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### **TRANSLATION FROM FRENCH**

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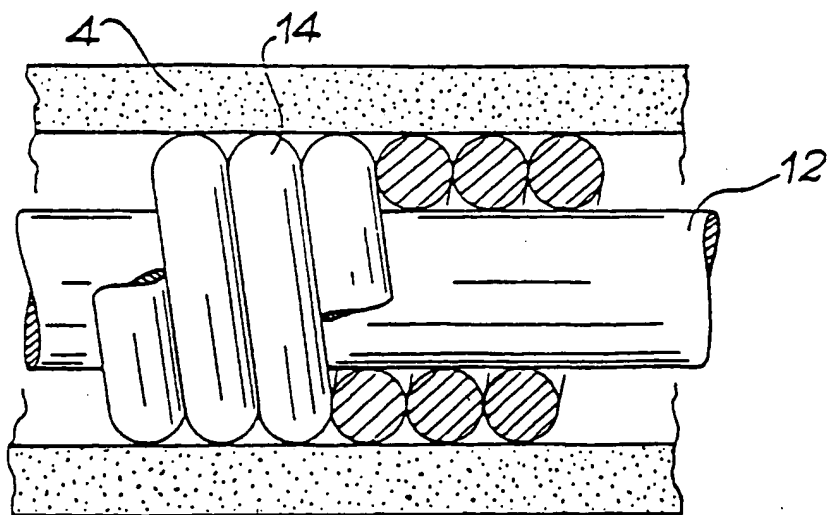
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(54) Synthetic String with Metal Core for a Musical String Instrument



(57) Abstract

String for a musical string instrument. The string is comprised of a core (2, 12, 14) which is at least partially metallic and is surrounded by a sheath (4) of synthetic material. The synthetic material is selected from the family including rilsan and nylon. The core (2) is comprised of a metal wire or of a gut string, of synthetic material or steel (12) to which are wrapped metal strands (14).

## Specification

The invention concerns a string for musical string instruments whose strings are plucked, strummed or struck.

The strings of musical instruments and especially guitars have traditionally been made of sheep gut, nylon, steel or composite: a core of gut or synthetic material on which metal wires are stranded. However, these strings exhibit various drawbacks.

Gut strings are fragile and frayable and their mechanical and acoustic characteristics vary strongly because of atmospheric conditions.

Nylon strings also exhibit mechanical instability because of moisture and temperature. During a first tuning it is difficult to obtain the desired acoustic performance. One must wait several hours for a second tuning to obtain this performance. To eliminate this drawback, partially at least, some guitarists stretch the string locally piece by piece to accelerate the stabilization.

Moreover, nylon strings lack output. The energy necessary to obtain displacement of the string (and thus to achieve a specific sound), must be increased. The force necessary for production of sound, which is obtained by imparting a displacement velocity to the string, must also be increased. This lack of output is conveyed by the necessity for very precise attack of the finger in terms of point of attack and angle of incidence. It is also necessary to communicate an amplitude and high velocity to the string.

If these conditions are not combined the sound produced by a nylon string lacks power and is not very audible. This means that only a very good guitarist is capable of obtaining a rich tone and high power from a nylon string.

Moreover, nylon strings lead to rapid attenuation of the sound which is partly due to the low density of this material.

Steel strings, as such, present other shortcomings. Attack of the string with the fingers is difficult because of the limited diameter of the string. It is therefore necessary to use a mediator or plectrum. It is also very difficult to modify the tone of the string by varying attack of the string owing to the fact that the sound of a steel string is typically metallic. An instrument using steel strings must therefore be limited to some types of guitars: folk, jazz, electric, limited to particular repertoires, such as folk, jazz or rock music.

Stranded strings, metal wires on a core of gut or synthetic material, mounted on classical guitars to obtain the low notes, wear rapidly. This means a very rapid loss of output after 1 or 2 hours of playing. In addition, a string of this type produces a characteristic sound (called "zip") when the fingers of the guitarist are moved on it. This parasitic sound is particularly troublesome during studio recordings.

Stranded strings, metal wires on a steel core, mounted on folk, jazz or electric guitars, exhibit the same defects.

Finally, it is customary to combine nylon strings and stranded strings on a classical guitar. For example, on a guitar containing six strings three will be made of nylon and the other three stranded. Use of strings of different nature results in additional shortcomings. There is an absence of homogeneity of tone of the high-pitched strings (nylon) relative to the low-pitched strings (stranded). The tone is characterized by the spectrum of harmonics of the string from attack to extinction of the sound. The tones of the two groups of stranded and nylon strings are different. In effect, the high-pitched harmonics of the low-pitched strings are paradoxically richer than the high-pitched harmonics of the high-pitched strings. Moreover, as already explained, a nylon string requires very precise attack by the guitarist in terms of point of attack and angle of incidence of the finger. Stranded strings are more tolerant in this respect. This therefore produces a lack of homogeneity of the sound produced by the nylon strings and by the stranded strings.

Attempts have already been made to create strings that remedy the aforementioned shortcomings. For example, French Patent Application No. 85 16866 from November 14, 1985 describes a string of a musical instrument made of a synthetic wire (copolymer based on vinylidene fluoride) in which the density can be increased to  $1.7 \text{ g/cm}^3$  instead of 1.15 for nylon or rilsan. Because of this increase in density an improvement in sound quality is obtained. However, this density still remains insufficient to completely eliminate the drawbacks already mentioned.

Finally, a string for musical instruments is known (FR-A-2 547 673) consisting of a core of gut on which a silver wire is wound between whose turns tungsten wire of smaller cross section is interposed.

The silver is used to produce a wire wound around the core made of gut since it is a relatively soft and dense ductile metal that readily permits stranding. However, this metal is

expensive. A string of this type exhibits the drawbacks of stranded strings, although polishing after stranding reduces the significance of the characteristic "zip" sound without eliminating it. Polishing also reduces the acoustic performance of the string.

The precise purpose of the present invention is a string for musical instrument that eliminates these shortcomings.

More precisely, the purpose of the invention is to create a string of greater density in order to increase its power and reduce attenuation of the sound. This string must permit better homogeneity of tone between the low-pitched strings and the high-pitched strings, while permitting variation of the tone by changing attack of the string. It must permit elimination of the tuning difficulties, which are a characteristic phenomenon of nylon strings. Finally, it must avoid the characteristic "zip" of stranded strings. Moreover, it must exhibit good durability obtained by significant wear resistance.

These objectives are reached according to the invention with an at least partially metal core surrounded by a sheath made of synthetic material. This synthetic material is chosen in the family comprising rilsan and nylon. The metal core is preferably steel or a material exhibiting similar mechanical characteristics.

According to one variant the string comprises a core of synthetic material, for example, nylon, rilsan, gut or even steel surrounded by metal strands. This core is surrounded in turn by a sheath of synthetic material.

Other advantages and characteristics of the present invention will be apparent on reading the following specification of an example of a variant given as an illustration that is in no way limiting with reference to the accompanying figures, in which:

- Figure 1 is a cross section of a string according to a first variant of the invention,
- Figure 2 is an external view of a section of the core of a string according to a second variant of the invention,
- Figure 3 is a cross section of a string according to the invention containing the core shown in Figure 2,
- Figure 4 is a curve showing the sound level in decibels as a function of time in seconds of a G string of the conventional type made of nylon,
- Figure 5 is a similar curve showing the sound level as a function of time of a G string according to the invention,

- Figure 6 is a curve showing the spectrum of harmonics of a conventional nylon G string,

- Figure 7 is a curve showing the spectrum of harmonics of a G string according to the invention.

Figure 1 shows a cross section of a string according to the invention. This string comprises a metal core 2 made of steel or a metal exhibiting mechanical characteristics similar to those of steel. The metal wire 2 is surrounded by a core of synthetic material like nylon or rilsan. Rilsan is a material of the same family as nylon, but to which additives are added to improve wear resistance, shock resistance and resistance to ultraviolet. The metal wire 2 ensures the mechanical characteristics sought for the string; it increases the density of the string because of its own substantial density. This produces the sought improvement in sound quality. The sheath 4 made of rilsan, for example, modifies the tone of metal string 2. The sheath 4 is obtained by coextrusion with nylon, rilsan or any other equivalent material. Depending on the sought tone, the proportions (diameter) of core 2 relative to the outside diameter of the string can vary. For fairly broad utilization a string is made in which the outside diameter of the metal core is  $\frac{1}{3}$  the total diameter of the string. The following table shows as an example the outside diameter of the metal core as a function of outside diameter of the string.

Outside diameter of string (mm)	Diameter of metal core (mm)
95/100	35/100
75/100	25/100
65/100	15/100

The choice of diameters and proportions results from a compromise between mechanical characteristics and density. A homogenous material having the same density and same mechanical characteristics would not produce the same results as the composite string according to the invention, as shown by Patent FR-A-2 547 673. The string described there is an improvement in terms of density relative to nylon, but the acoustic results are not comparable to those of a string according to the invention.

The association of two materials, one rigid (the metal core) and the other flexible (the sheath of synthetic material), produces increased tension of the string because of the metal core and a type of reinforcement of the sheath on the metal core when this string is under

tension. This permits good connection of the two materials without disconnection having been made during fabrication.

The existence of reinforcement of the sheath of synthetic material on the metal core is attested to by measurement of the outside diameter of the string. For example, a string having an outside diameter of 0.930 mm at rest will have an outside diameter of 0.923 mm after being placed under tension and will stabilize after a few minutes at 0.917 mm.

Figures 2 and 3 show a variant of a string according to the invention. In this variant the core is a composite. It consists, on the one hand, of a nylon core 12 on which a metal strand 14 is wound. A sheath of synthetic material, like nylon, rilsan or something similar, designated with [4], as can be seen in Figure 3, is arranged on this composite core according to the invention. This sheath 4 avoids the characteristic "zip" of stranded strings. Moreover, the sheath 4 ensures the same advantages as those of the first variant in terms of acoustic qualities of the string.

Figures 4 and 5 compare the performances of an ordinary nylon G string and a G string according to the invention. Comparison of the two curves reveals weaker attenuation of the string of the invention. In the same fashion, Figure 6 shows the spectrum of harmonics of an ordinary nylon G string and Figure 7 shows the spectrum of harmonics of a G string according to the invention. Comparison of these two spectra reveals greater richness in harmonics of a string according to the invention.

The string being described thus enjoys numerous advantages over stranded strings and the traditionally used nylon strings. It exhibits weaker sound attenuation and permits easy modification of this attenuation by changing the proportions of materials. Use of a greater amount of nylon leads to higher attenuation. This string also exhibits better output. The energy and powers obtained are higher. The requirements of this string in terms of precision of attack of the finger are less than those of nylon strings. The lack of precision in terms of position of the finger, its angle of attack and its velocity of attack alters less the quality of the sound produced, which always presents a good level.

The margin of error permitted is therefore greater. It is also possible to act on this margin of error. Use of the metal core, for example, one made of steel, with a relatively greater diameter relative to the total diameter of the string, leads to a greater permitted margin of error.

The possibilities of obtaining different tones are increased relatively to steel strings. The tone can run from that of a nylon string to that of a steel string. This provides homogeneity of tone of the conventionally stranded low-pitched strings relative to the conventional nylon high-pitched strings.

The string of the invention also permits an increase in the tone possibilities for a given string and a given tuning. This causes better homogeneity of the tones of the low-pitched strings relative to those of the high-pitched strings. The harmonics of the high-pitched strings are greater than those of the traditional nylon high-pitched strings and run from 5000 Hz to 7800 Hz. The sound power obtained is more substantial than that of the traditional nylon strings. Comparison of Figures 4 and 5 shows a gain of 5 to 6 dB for a G string according to the invention relative to a traditional string. Moreover, the improvement in richness of harmonics is such that the guitar becomes audible when played amongst other instruments.

The string of the invention is adapted to several musical styles. This adaptation is obtained by varying the proportion of metal core relative to that of the nylon sheath.

Finally, although the string of the invention is preferably applied to a string instrument, like a guitar, it is also possible to adapt it to other instruments, like a harp, violin, piano and generally any instrument with plucked, strummed or struck strings.



## Claims

1. String for a musical string instrument characterized by the fact that it comprises an at least partially metal core (2, 12, 14, 16) surrounded by a sheath (4) of synthetic material.
2. String according to Claim 1, characterized by the fact that the synthetic material is chosen in the family comprising rilsan and nylon.
3. String according to any of the Claims 1 and 2, characterized by the fact that the core (2) consists of a metal wire.
4. String according to Claim 3, characterized by the fact that the metal wire (2) is made of steel.
5. String according to any of the Claims 3 and 4, characterized by the fact that the diameter of the metal wire forming the core is about  $\frac{1}{3}$  the outside diameter of the string.
6. String according to any of the Claims 1 and 2, characterized by the fact that the core consists of a string made of gut, synthetic material or steel (12) on which metal strands (14) are wound, this core being surrounded by a sheath of synthetic material (4).

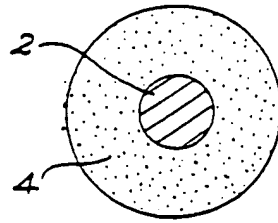


FIG. 1

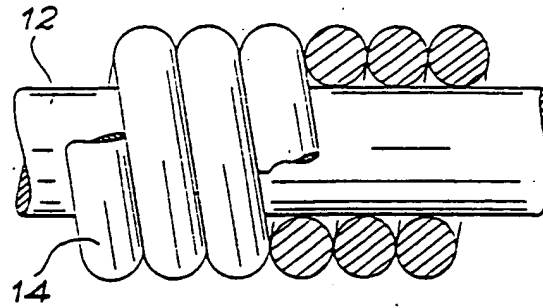


FIG. 2

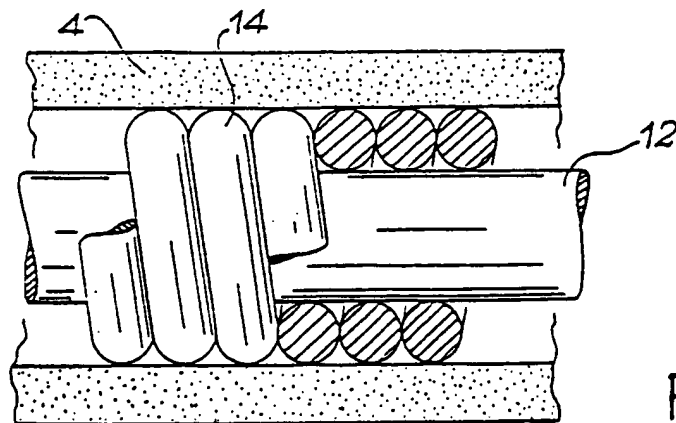
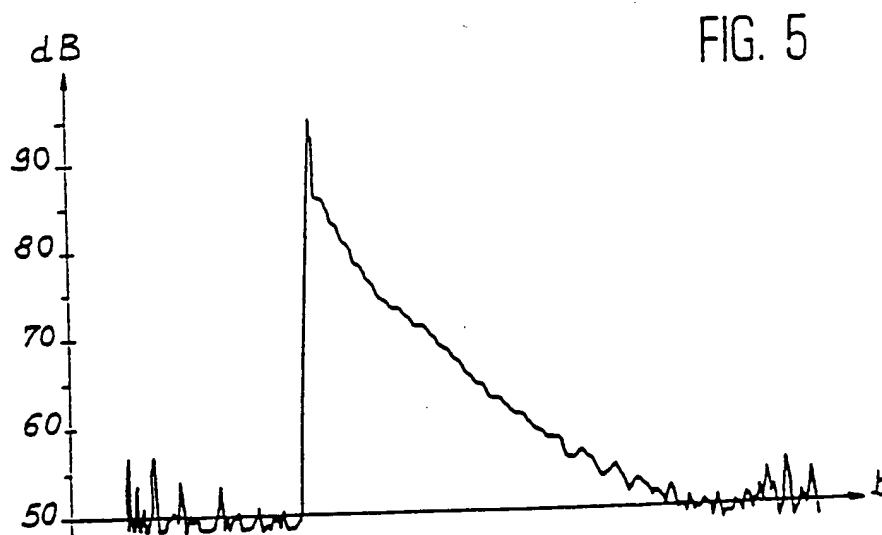
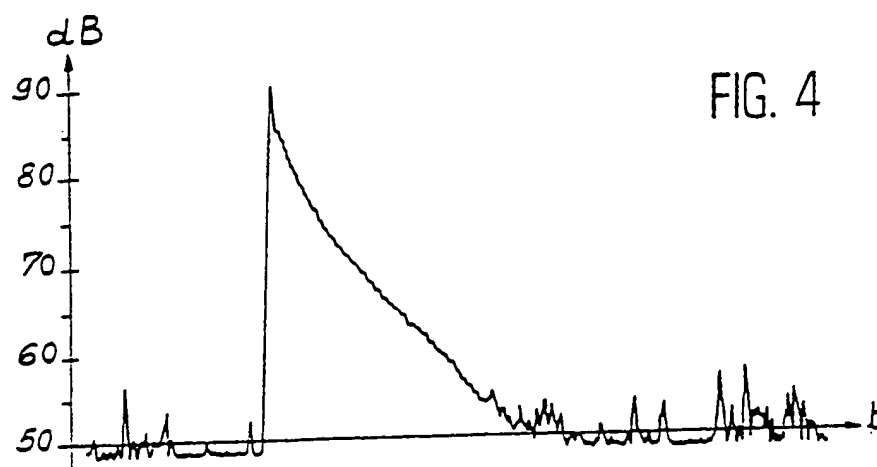
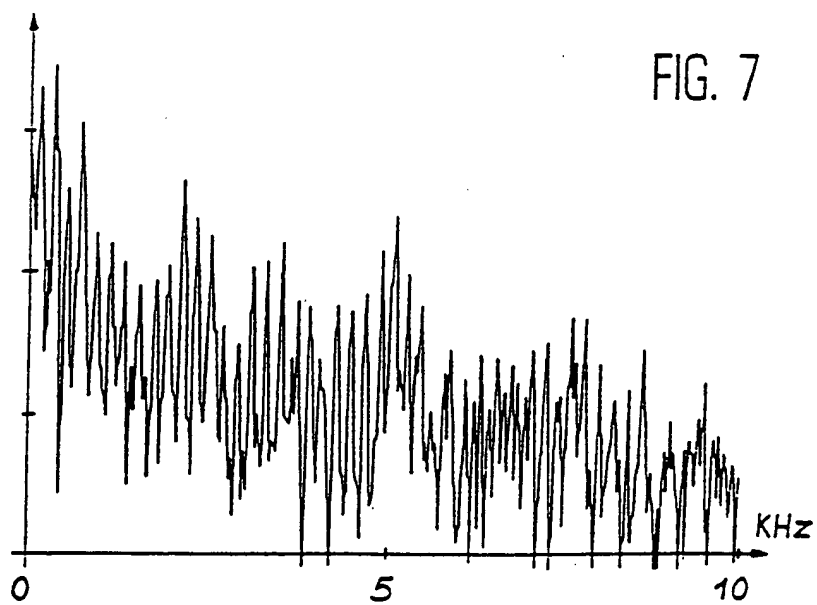
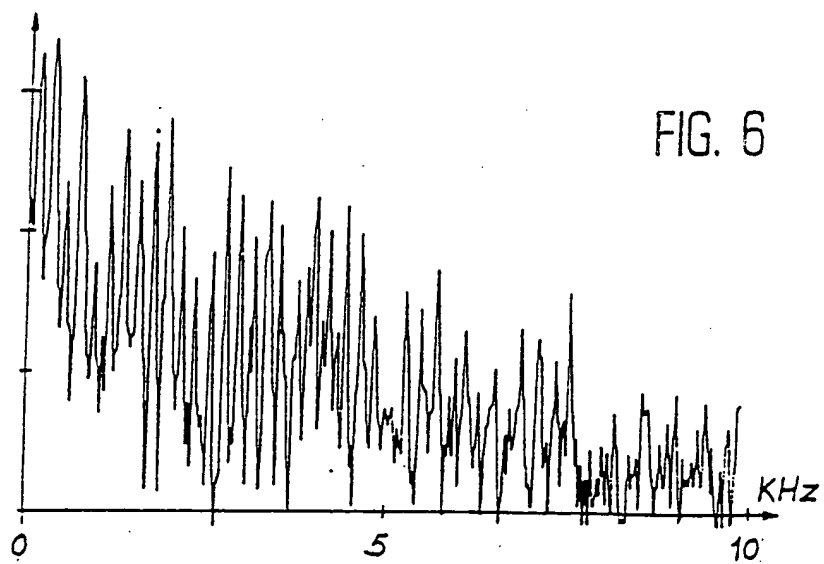


FIG. 3





# INTERNATIONAL SEARCH REPORT

International Application No. PCT/FR 89/00413

## I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) \*

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl. 5 G 10 D 3/10

## II. FIELDS SEARCHED

Minimum Documentation Searched \*

Classification System

Classification Symbols

Int. Cl. 5 G 10 D 3

Documentation Searched other than Minimum Documentation  
to the Extent that such Documents are Included in the Fields Searched \*

## III. DOCUMENTS CONSIDERED TO BE RELEVANT \*

Category \* Citation of Document, \*\* with indication, where appropriate, of the relevant passages \*\* Relevant to Claim No. \*\*

Y	DE, A, 2704836 (ASHAWAY LINE & TWINE) 10 August 1978, see claims 1-4 ---	1-3,6
Y	DE, C, 200763 (POPPER & CO.) 27 July 1908, see claims 1,2 ---	1,3
Y	FR, A, 1190769 (BABOLAT-MAILLOT) 15 October 1959, see page 1, column 2, line 2 - page 2, column 1, line 3 ---	1,6
A	US, A, 2096787 (M. CONTI) 26 October 1985, see column 1, lines 1-28; figures 1,2 ---	1,3,5
A	FR, A, 963002 (J. KOSMIS) 27 June 1950, see claim 1 -----	2

\* Special categories of cited documents: \*\*

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principles or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"Z" document member of the same patent family

## IV. CERTIFICATION

Date of the Actual Completion of the International Search

4 December 1989 (04.12.89)

Date of Mailing of this International Search Report

28 December 1989 (28.12.89)

International Searching Authority

European Patent Office

Signature of Authorized Officer